

TRANSACTIONS
OF THE
COMMONWEALTH CLUB
OF CALIFORNIA

VOL. XII

OCTOBER, 1917

No. 8

7

Hetch Hetchy Construction

The object of the Commonwealth Club shall be to investigate and discuss problems affecting the welfare of the Commonwealth, and to aid in their solution.—Article VI, Constitution.

The Commonwealth Club shall maintain itself in an impartial position as an arena for the discussion of disputed questions.—Rule VI adopted by the Board of Governors, 1910.

SAN FRANCISCO, CALIFORNIA

1917

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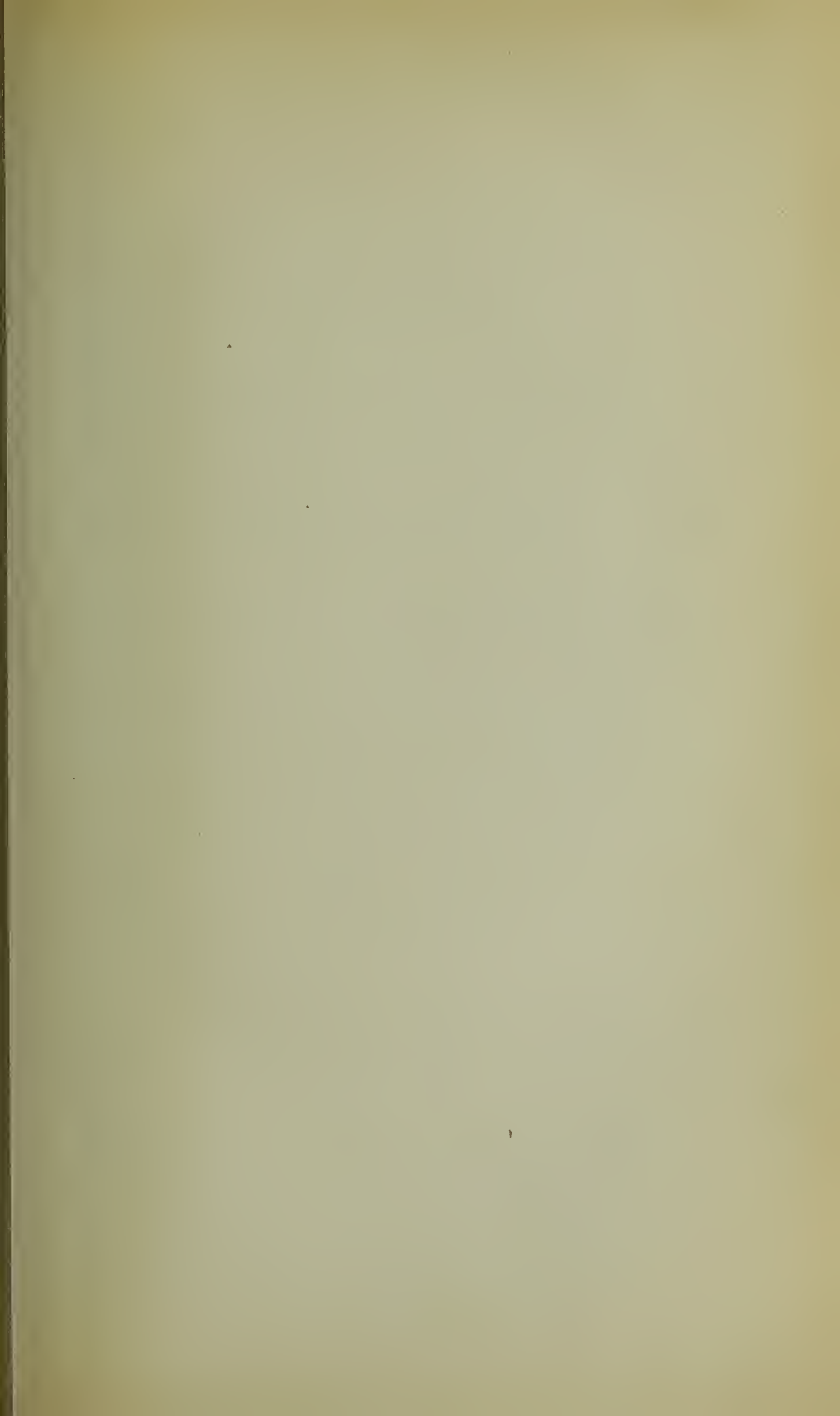
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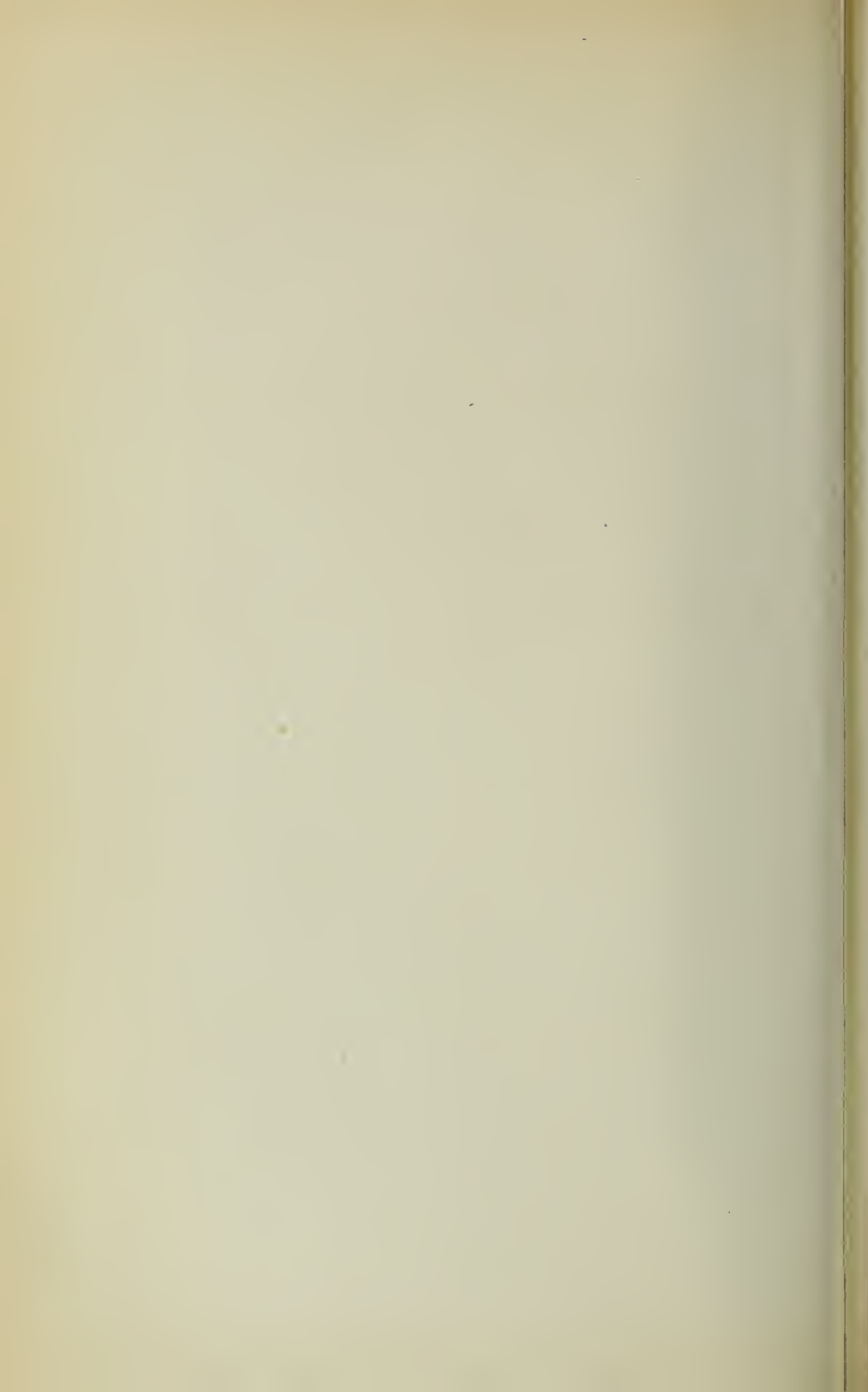
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HETCH HETCHY CONSTRUCTION

The Club Meeting of September, 1917, was set aside for a statement of progress on the Hetch Hetchy water project. The subject of a water supply for the bay cities has received much attention from the Club and its discussions have contributed to a settlement of the question. Reports of the Club's activities in the solution of this problem will be found in the Transactions of the Club, Vol. II, No. 7, "Water Supply for San Francisco," June, 1907; Vol. IV, No. 6, "The Hetch Hetchy Water Supply," November, 1909; Vol. IX, No. 1, "Bay Cities Water Supply," February, 1914; Vol. X, No. 6, "The Bay Cities Water Problem," June, 1915; Vol. XI, No. 4, "A Bay Cities Water District," July, 1916.

With the signing of the Act of Congress of December 19, 1913, the question of a source of supply was settled. There remain, however, the problems of construction of the works, of the financing the cost, of distribution of water in accordance with the needs of the various communities about the bay, and of the management and control of the supply.

At the meeting of September 12, 1917, M. M. O'Shaughnessy, City Engineer of San Francisco, reported on the construction work accomplished and that planned for the immediate future by the city of San Francisco. The further problems still remain for solution, no progress having been made in the formation of a water district since the report published in the Transactions, Vol. XI, No. 4.

Meeting of September 12, 1917

The regular meeting of the Commonwealth Club of California was held at the Hotel St. Francis, San Francisco, September 12, 1917. At the conclusion of the dinner and business meeting, President Hodghead introduced the programme of the evening as follows:

Remarks by President Beverly L. Hodghead

THE PRESIDENT: I believe the Hetch Hetchy project is older than the Commonwealth Club and has also had more politics in it, which in its earlier stages somewhat retarded its progress.

The question this evening is very different from the question that presented itself in the many discussions that have taken place before this body from time to time. The usual question has been, shall Hetch Hetchy be the permanent source of water supply for San Francisco; now that we are discussing construction work, the question is, when shall Hetch Hetchy become the permanent source of water supply for San Francisco?

This evening we are to listen to the City Engineer, who will give us a report with lantern slide illustrations of the progress of the construction work on the Hetch Hetchy project.

This has been a long controversy. It began many years ago, almost twenty years or more. I think our Vice-President, Mr. Grunsky, was the father of the Hetch Hetchy project, he having, while he was City Engineer, recommended it as the source of supply for San Francisco, and on his recommendation Mayor Phelan in 1901 filed the original location notices and made application to the Federal Government for a reservoir site. This application, as you remember, was denied by Secretary Hitchcock in 1903, and later was withdrawn by the Schmitz Board of Supervisors. Again, when the Taylor Board came in, the application was renewed, when Mr. Marsden Manson was City Engineer, and a rehearing granted in 1908, resulting in the so-called Garfield permit for the use of Hetch Hetchy and Lake Eleanor as the source of supply. In 1910 Secretary Ballinger was in office and he issued his order to show cause why Hetch Hetchy should not be eliminated from the Garfield grant. A number of hearings were had in Washington, resulting in the appointment of an advisory board of army engineers. The city at the same time appointed a group of engineers, among whom was John R. Freeman, and a very exhaustive report was filed in February, 1913, recommending that the Hetch Hetchy source be approved and the permit granted. That report, as I recollect it, was not approved by Secretary Fisher, who was then in office, further than to refer the whole matter to Congress, just about the time he was retiring from

office in February, 1913. Secretary Lane, who succeeded him, approved this action, and the matter was taken out of the hands of the Secretary of the Interior and referred to Congress, culminating in the adoption of a new bill, which was signed by President Wilson in December, 1913.

I think this is the tenth meeting which this Club has devoted to a discussion of the water supply for San Francisco. I recollect in December, 1906, after the application had been withdrawn, we invited Professor C. D. Marx of Stanford University, to prepare and read before the Club a paper on this question of water supply. That paper was followed by a number of spirited discussions in the Club, occupying meetings in February, March and April of 1907, and resulting in the adoption of a resolution requesting the Board of Supervisors of San Francisco to reappoint the Board of Engineers who had been considering the question and that an application be made for a rehearing of petition before the Secretary of the Interior, which was granted, as I say, by Secretary Garfield in 1908. Then, we had two meetings in 1909; at the first one a committee of laymen was appointed to visit Hetch Hetchy and to report upon the physical features of the valley, its scenic beauty, and such other matters as were in dispute. President Adams announced that he had appointed on that committee the three most contrary members of the Club, including Mr. Walcott and Mr. Frank Adams; and I would not like to disclose the identity of the Committee any further than that. (Laughter.) The next meeting in November, 1909, was devoted to a discussion of that report.

Then, while the latest bill was under discussion in 1913, there was another meeting devoted to the discussion of that proposed grant, the so-called Hetch Hetchy grant or Raker bill. In 1914 we held a meeting after the adoption and approval of that measure, a sort of ratification meeting, where a good many men who took part in that contest in Washington were heard. In 1915, in May, we had a meeting here which was in the nature of a post-mortem or inquest after the attempt to secure some of the Spring Valley Water Company properties for thirty-four and a half million dollars had failed. And this meeting I think will be number ten. We shall have, as I say, the report of the City Engineer upon the progress of the Hetch Hetchy construction—Mr. O'Shaughnessy, whom I am glad to present to you. (Applause.)

The Hetch Hetchy Water Supply Project

By M. M. O'Shaughnessy, City Engineer, San Francisco, California

MR. O'SHAUGHNESSY: The Chairman's story about the length of time it has taken to launch Hetch Hetchy reminds me very much of a conversation I heard on a sight-seeing wagon in New York in 1904. The spieler was carrying us around, and pointing to a structure on top of a hill said, "That is the church of St. John the Divine. Ten years ago there were four men and a boy working on it, and now there are five men busy on it because the boy has grown to be a man." And so, possibly, the same application could be made to our Hetch Hetchy project. A brief historical review of the past history of San Francisco's efforts to procure an adequate water supply is desirable before going into the details of the present Hetch Hetchy project.

In 1874 the City of San Francisco employed an eastern engineer named Scowden, who reviewed various sources and recommended the Calaveras for the supply of San Francisco. Due to lack of concentrated effort the city permitted this site to fall into the possession of the Spring Valley Water Company, which purchased the reservoir lands, and in connection with the general apathy then prevailing, deferred any activity for the time being.

In 1901 the City Engineer was ordered to and did make an investigation of various possible sources of water supply and out of fourteen sources examined selected the Tuolumne as being superior in quantity, quality and accessibility to all the others. The original Hetch Hetchy project of 1901-1902 as outlined by Engineer Grunsky was based on an initial development of sixty million gallons daily from Hetch Hetchy Valley, with Lake Eleanor as a reserve for future use. The supply was to be ultimately increased to 160 million gallons daily. This was first to be developed through a conduit with

28 miles of open canal
13 miles of tunnel
141 miles of double line of 48-inch pipe
<hr/>
182 miles total length

with accessory pumping structures over Altamont Pass.

Two small drops were obtained along the Sierra portion of the route to develop power for pumping purposes over Altamont summit on the Diablo range.

Due to change of municipal administration, with the advent of Mayor Schmitz, all activities on the project were suspended.

The Garfield Permit

In a large measure the revival of the project must be credited to my predecessor, Marsden Manson, as the result of whose untiring energies Secretary Garfield granted the permit which bears his name, May 11, 1908. Certain conditions of the Garfield permit limited development to Lake Eleanor as a first stage of construction and deferred activity at Hetch Hetchy to a future date. City Engineer Manson in 1908 revised the original plan of Engineer Grunsky and devised a scheme for initial development of sixty million gallons daily and ultimately two hundred million gallons daily, with 40,000 hydro-electric horsepower. The construction involved

27 miles of cut and cover aqueduct	}	300 M. G. D.
30 miles of tunnel		
125 miles of double pipe line 50 inches in diameter, 60 M. G. D. capacity		
<hr/> 181 miles total length.		

It should be noted that by using Eleanor and Cherry first, the city would secure the yield of 193 square miles of watershed, instead of the catchment of 459 square miles of watershed from the Hetch Hetchy source. In other words, Cherry and Eleanor combined as water producers were about one-half the value of Hetch Hetchy. Hence the desire of the city, in view of future requirements, to have the most ample source when such a long aqueduct had to be built to bring in water to San Francisco.

The people of San Francisco, by a vote of 34,572 for and 5,647 against, voted \$600,000 in bonds November 12, 1908, to acquire lands near Lake Eleanor held in private ownership, and later on January 4, 1910, by a vote of 32,886 for and 1,609 against, \$45,000,000 to build a mountain water supply from sources including "Lake Eleanor and waters of Tuolumne River and tributaries."

Now, you will notice this language, "Lake Eleanor and waters tributary to Tuolumne river." This does not confine us to any particular part of Tuolumne river, but only this past week I heard a rumor intended to cast a cloud on our project, which originated from Mr. Vanderlip, the President of the National City Bank of New York, who communicated with the Anglo-California Trust Bank here and told them that they would not take the balance of our bonds as there was a doubt as to the legality of the title. So much for Mr. Vanderlip.

In spite of the city's then willingness to proceed on construction at Cherry and Eleanor, with Hetch Hetchy as a future reserve under the Garfield permit, the United States Government authorities sought to interfere with this programme.

On February 25, 1910, Secretary of the Interior R. A. Ballinger called upon the Mayor and Supervisors of San Francisco to show cause why the Hetch Hetchy valley and reservoir site should not be eliminated from the above permit.

Now, Secretary Ballinger's authority came in because he had jurisdiction as Secretary of the Interior over the Yosemite National Park.

At this stage Mr. John R. Freeman, an eminent hydraulic engineer, with successful experience on large supply projects in Boston and New York, was retained by the city, with several corps of engineers, to assist in resisting the withdrawal of Hetch Hetchy from the city's future sources.

By special orders No. 116 the War Department, on May 18, 1910, appointed a board of officers of the Corps of Engineers, for the purpose of advising the Secretary of the Interior on the controversy. This board, comprising Colonels Biddle, Taylor and Cosby, on February 19, 1913, after two years investigation, reported to Secretary Walter L. Fisher, endorsing the contentions of San Francisco and recommending the grant of Hetch Hetchy to the city. They further found that the following situation will confront the communities around San Francisco bay:—

The Army Board Plan

(a) Purchase of Spring Valley Water Company, \$35,000,000 to \$40,000,000.

(b) Further development of this system to \$10,000,000 additional outlay.

(c) Purchase of other systems around San Francisco bay.

(d) Construction of Tuolumne system, during period of fifty years, to cost \$77,000,000.

(e) Above expenditures should be credited with 115,000 horsepower having an estimated capitalized net value of \$45,000,000.

Secretary Fisher, notwithstanding the report of the Army Engineers, the exhaustive reports of Mr. John R. Freeman, and others, which involved an expense for preparation aggregating \$250,000 to the city of San Francisco, went out of office on the 4th of March, 1913, after rendering a neutral decision that gave satisfaction neither to the city nor its antagonists.

The nature lovers, bay water companies, San Joaquin irrigationists, power companies, and others lined up against the city with a campaign of misrepresentation which was widely diffused through the eastern press.

So effective was this campaign that one of the editors of the Chronicle here told me before I went east in November, 1912, that sentiment

was so crystallized in the east that we never could get Hetch Hetchy. The city authorities finally got tired of being juggled by the changing minds of successive Secretaries of the Interior, and decided to make direct appeal to Congress, to get a grant of rights to Government lands in the Sierras, in the Yosemite National Park and Stanislaus National Forest, and in June, 1913, the City Attorney, City Clerk and myself were delegated by the Mayor and Supervisors to get such an act passed. On August 5, 1913, a favorable report was got from the Land Committee of the House and such a bill subsequently passed that body, and also after further hearings in the United States Senate, was approved and secured the Presidential signature, December 19, 1913.

Having succeeded Mr. Manson as City Engineer, September 1, 1912, the final shaping of the engineering features of the project and the protection of the city's interests were assumed by me.

The Freeman Report

The exhaustive work of Mr. Freeman simplified in a large measure decisions on the determination of many of the problems involved. His scheme recommended as stages of construction :—

1. Low dam at Hetch Hetchy.
2. Nineteen and one-half miles of 400 million gallon daily capacity pressure aqueduct, ten feet in diameter with ten feet fall per mile from a point at Early intake, twelve miles below Hetch Hetchy, to Priest surge chamber, where a power drop of 1425 feet would create 70,000 mechanical horsepower.
3. Power drop to Moccasin Creek.
4. Sixteen miles of 400 million gallon daily capacity aqueduct tunnel twelve feet eight inches diameter from Moccasin creek to east side San Joaquin valley.
5. Forty-five miles of seven and five-tenths foot diameter steel pipe across San Joaquin valley, two hundred and sixty million gallon daily capacity.
6. Thirty-one and one-half miles of twelve foot eight inch tunnel through Diablo range to Irvington.
7. Forty-seven and one-half miles of tunnel or pipe six and five-tenths feet diameter, two hundred million gallon daily capacity, to San Francisco, making a total length of 159½ miles.

While Mr. Freeman generally outlined the Hetch Hetchy supply to come directly to the city, at page 63 of his report he states :—

“I have designed the city end of the Hetch Hetchy aqueduct in the belief that this (Spring Valley) purchase will be effected, and that the much better mountain water will be used, while the peninsula sources will be held in reserve and perhaps be made useful meanwhile as an aid to irrigation.”

Mr. Freeman had always in mind the broadening out of the scheme into a metropolitan project for the bay communities, who were expected to co-operate in the construction and ownership of the project.

The final framing of the scheme before the House Committee in 1913, modified in many ways the proposals in Mr. Freeman's book, written for the Army Board a year before:—

The most important departure was the agreement of the city not to bring initially one hundred and fifty million gallons daily across the San Joaquin valley for use of irrigationists around Niles, as the contention was made by the Turlock and Modesto irrigationists that the city should not discriminate between irrigation users. The limited area around Niles available for irrigation, the abundance of well water in this region, as well as the great cost of building a needlessly large, expensive pressure pipe line forty-five miles long across the San Joaquin valley, show clearly the desirability of building at first a smaller line, say of sixty million gallons per day capacity across the San Joaquin valley.

San Francisco is now using forty million gallons daily from Spring Valley, which at moderate expense can be increased by twenty million gallons daily additional, as well as ten million gallons daily from wells. This supply has taken care of the city for sixty-five years, and eighty million gallons daily additional, including the city's first sixty million gallons daily unit, should take care of us till 1950. While the wisdom of initially building tunnels ten to twelve feet in diameter of four hundred million gallons daily capacity cannot be questioned, as it does not pay to add to the size of a tunnel on the installment plan, there can likewise be no question of the wisdom of limiting the size of steel pipe lines to a capacity not exceeding a need of forty years. The outlay for an unnecessarily large pipe, the possibility of deterioration and other factors suggest the desirability of supplementing future supply by then building additional pipes.

The irrigationists held certain concessions under the Garfield permit, to make reservoirs above the city's dam sites on the higher mountain basins. This ownership would lead to perpetual future bickering, so the city's representatives succeeded in June, 1913, in cancelling these claims, and substituting the alternative terms in the bill by which the districts should pay for such stored water as the city might release at cost. This cost would be based on the city's outlay for lands and reservoir rights and structures, and figuring the quantity of acre feet impounded, the irrigationists should pay a definite price per acre foot, to be determined when those elements are computed in the future.

While the irrigationists accepted these conditions in June, 1913, through their Congressmen Church and Needham, and their other delegates in Washington, and publicly on record commended the fairness of San Francisco, two months afterwards, due to misrepresentation, some of those bodies and delegates changed their minds, and were supported

by Senator Works in November, 1913, in endeavoring to break their compact and block the city's acquisition of Hetch Hetchy, which they failed to do.

Since the city was occupying a territory with great power possibilities—a substantial asset to the nation—we were compelled (by conditions imposed by the United States Government) to proceed promptly with the construction of power plants in the final project, rather than adopt the remote future *laissez-faire* power development policy suggested by Mr. Freeman. Fortunately the water project with very little additional outlay lends itself admirably for this purpose. To obviate blunders and get the best available talent on this feature of the work I had, on May 4, 1914, a board of hydro-electric engineers, who are masters of the art on high pressure plants, Messrs. Durand, Baum, and Galloway, pass on the critical structural features, and revise some of the preliminary power suggestions of Mr. Freeman, whose experience has been largely with low-head projects in the east.

The result of their findings was the substitution of a 2800 acre foot forebay reservoir, containing two and one-half days' flow of the canal, three-quarters of a mile south of Priest's, into which the aqueduct will discharge instead of the surge chamber proposed by Mr. Freeman. This will materially improve the flexibility of the power plant, running it at peak periods up to 100,000 horsepower, and materially simplify the construction of the nineteen miles aqueduct, relieving it from the pressure conditions previously proposed and making it practically a gravity conduit.

Conditions of the Grant

On December 19, 1913, President Wilson signed the Hetch Hetchy grant, an act giving to the city of San Francisco power to develop in the Yosemite National Park a domestic water supply. This development, when completed, will be sufficient to meet the needs of San Francisco and all of the cities bordering on San Francisco bay for over one hundred years to come.

By the terms of the bill the city was also given the right of way through the Yosemite National Park and Stanislaus National Forest for an aqueduct through which the mountain water can be conveyed to San Francisco. Right of way for transmission lines is also provided, it being the intention to develop in conjunction with the water supply sufficient power to run municipal railways, light the city's streets and provide electricity for all other municipal needs of this city, as well as a liberal surplus which will be sold to the irrigation districts in the San Joaquin valley, at cost.

Since the signing of the Hetch Hetchy grant, San Francisco has not been idle in the Sierras. During the three and one-half years which have elapsed since the signing of the bill, a railroad sixty-eight miles in length, extending from Hetch Hetchy Junction (formerly Rosasco), a station on the Sierra Railway twenty-six miles northeast of Oakdale, to Hetch Hetchy dam site, has been built; a power plant has also been constructed, which will provide electricity for all of the construction operations in the mountains; the main aqueduct tunnel has been started; the floor of Hetch Hetchy valley has been cleared of timber; a diversion tunnel has been bored around the site for the main Hetch Hetchy dam, through which the waters of the Tuolumne will be diverted while that structure is in progress; a multiple arch dam is being rushed at Lake Eleanor, to provide the requisite storage during the three months of low stream flow each year for the temporary power plant at Early intake; the main Hetch Hetchy dam has been designed, specifications for its construction are being prepared, and bids will be called for if funds are available during the present year; the main aqueduct survey has been completed to San Francisco, and work of acquiring the right of way started.

Two serious handicaps have tended to delay the construction programme. The first has been the difficulty which the city has experienced in disposing of its water construction bonds at par; the second, the fact that before the completion of the railroad, the severe climatic conditions of the high Sierras has made continuous efficient work impossible during winter and a portion of spring. During 1914, when our Municipal Railway bonds were floated, we had to place those bonds on a five per cent basis; there was then no sale for four and one-half per cent bonds. Hence, as long as there were three and a half million dollars of Municipal Railway bonds at five per cent for sale, those four and one-half per cent bonds were not marketable, and they remained unsalable in the city treasury.

The most economical method of disposing of the city's bonds has been the subject of much heated debate by financiers and the executive department of the city's government. A proposal was received in 1915 whereby practically the entire bond issue would be purchased at par. This would mean, however, that the city would pay interest from that date on \$45,000,000 of securities during the entire construction period, which would involve an exceedingly heavy burden on the taxpayers of San Francisco. A more logical scheme seemed to be to dispose of the bonds as they were actually needed, thus saving to the city millions of dollars in interest. After bids for the construction of the Hetch Hetchy railroad were received in December, 1915, a delay in beginning of many

months was caused by the fact that there were not in the city treasury sufficient water construction funds to allow of the contract being signed. This emergency was met by disposing of bonds of early maturities. Appended hereto is a table showing the maturities of all the Hetch Hetchy bonds and the amount of each year's maturities that have so far been disposed of.

In January, 1917, the City Engineer transmitted to the Mayor, the Board of Public Works and the Board of Supervisors, a report on the progress of the work, requesting appropriations for the mountain division of the tunnel aqueduct to the amount of \$6,000,000; \$4,000,000 for the construction of the Hetch Hetchy dam, and \$1,000,000 for miscellaneous construction. The report closed with the following paragraph: "It is recommended that the Board of Supervisors sell bonds to the amount of \$11,000,000 in order to provide funds for the work to be undertaken during the present year. As the bond market will probably be in the best condition about March 1st, arrangements for this sale should be consummated as rapidly as possible."

Unfortunately, the Finance Committee of the Board of Supervisors delayed action on this recommendation until after war was declared on Germany on Good Friday, April 6, 1917.

Bids were received on April 16, 1917, for the purchase of bonds to the amount of \$11,090,000. One conditional bid was received—that of the Anglo & London Paris National Bank, which bid \$1,641,148 for bonds with a par value of \$1,640,000, to be delivered immediately. On the basis of the city accepting this bid, an option was to be given for the delivery of \$5,000,000 worth of bonds on July 1, and \$4,450,000 on October 1, 1917. This proposal was accepted. On May 28, 1917, a resolution was passed by the Board of Supervisors granting to the Anglo & London Paris National Bank an extension of one month in which to exercise its option on the purchase of the \$5,000,000 worth of bonds. On July 30, 1917, a communication was received by the Clerk of the Board of Supervisors from the Anglo & London Paris National Bank, signed by J. W. Lilienthal, Jr., notifying him that the bank had decided not to exercise its option to purchase the \$5,000,000 worth of bonds, the reason given for its failure being the present unfavorable condition of the bond market. Had the City Engineer's recommendation of January, 1917, been acted upon promptly, it is probable that the entire \$11,000,000 bond issue could have been disposed of at a liberal premium, for the bond market for municipal securities reached its highest point for the present year about the end of March.

The first step which was taken in the development was to build good wagon roads into Hetch Hetchy dam site, to the site of the temporary

power house at the Early intake, and to various other points where construction was to be carried on in the mountains.

I want to advise you that we got busy very quickly on clearing the bottom of the reservoir with the available money at hand. The nature lovers gave us so much trouble over those trees in the bottom of Hetch Hetchy valley that we did not want another Secretary of the Interior to block clearing those trees again, so we made a very quick job, and now there is a very good crop of potatoes on part of the floor of the valley.

The heavy rains and snows of the high Sierras rendered these roads practically impassable for motor truck haul for about four months of each year. The laying of the rails to Hetch Hetchy, which was completed a few days ago, will largely eliminate this source of delay on future construction.

Comparing the progress of construction on the Hetch Hetchy project since the signing of the Hetch Hetchy grant in 1913, with progress on the Catskill water supply for New York City, it can be seen that San Francisco has not delayed in developing its supply in the Sierras.

Comparisons of Progress

The Catskill aqueduct project comprises fifty-five miles of cut-and-cover aqueduct, seventeen feet by seventeen feet six inches; fourteen miles of grade tunnels, thirteen feet four inches by seventeen feet; seventeen miles of pressure tunnels, generally fourteen feet in diameter, and six miles of steel pressure pipe siphons, or a total of ninety-two miles of aqueduct from Ashokan to Hill View reservoir. Beside this there are eighteen miles of city tunnel and fourteen miles of steel and cast iron pipe varying in size from sixty-six inches to thirty-six inches, leading from the end of the city tunnel.

The first report which led to the adoption of the Catskill project was made in 1897. Between 1897 and 1905, the engineering details of the project were planned and estimated. In October, 1905, the report of the Board of Water Supply Commissioners, recommending the development was submitted and approved by the Board of Estimate and Apportionment, and in May, 1906, the approval of the state authorities was obtained.

The first Catskill water was delivered into the distribution pipes of New York City at a cost of \$130,000,000 on December 27, 1915, nine and one-half years after the approval of the project as designed. No power development is included in the Catskill project.

San Francisco's final proposed Hetch Hetchy development comprises sixty-eight and three-tenths miles of pressure tunnels; eighty--

eight and two-tenths miles of pressure pipe and one-half mile of sidehill aqueduct, or a total of one hundred and fifty-seven miles of aqueduct, from Early intake to the county line of San Francisco, so it cannot be expected that this great work can be finished at least for six years to come. Beside this, in the San Francisco development will be generated electric power for which the initial installation will be 66,000 horsepower, and the ultimate development in the neighborhood of 200,000 horsepower. If the present unsettled financial conditions continue, it is difficult to predict how much longer the construction period will be extended. At the present time, deliveries of structural materials of all descriptions are extremely uncertain; electrical equipment likewise, and manufacturing concerns are very independent as to guaranteeing any deliveries whatsoever.

The Owens River project of the Los Angeles aqueduct, costing \$27,000,000, comprises twenty-three and eight-tenths miles of open unlined canal; thirty-eight and nine-tenths miles of lined uncovered canal; ninety-seven and seven-tenths miles of lined and covered conduit; forty-two and nine-tenths miles of tunnels; nine and four-tenths miles of steel pressure siphons; two and six-tenths miles of concrete siphons; two-tenths mile of concrete flume, and reservoir lengths aggregating seven and nine-tenths miles, or a total of 223.4 miles. Active work on the permanent construction was begun in June, 1907, and the first water was delivered at the terminal point in November, 1913, or approximately six and one-half years after construction was started. It was proposed to develop along the line of the Los Angeles aqueduct power aggregating 49,000 horsepower. Work still remains to be done on this hydroelectric power development. Moreover, the country through which the Los Angeles aqueduct passes with its more favorable physical features, and its freedom from mountain snows and Sierra winter conditions, was much easier of access and better adapted for rapid and cheap construction than the mountain and foothill country through which the Hetch Hetchy aqueduct will pass.

The Hetch Hetchy Dam

In the mountain division of the Hetch Hetchy project the great construction features will be the Hetch Hetchy dam, the mountain division of the Hetch Hetchy aqueduct, and the Early intake—Moccasin Creek Tunnel aqueduct.

The dam will be a cyclopean concrete structure, 325 feet in height from the crest to the stream level. It will be 850 feet in length along the crest and slightly over one hundred feet in length along the upstream edge at the foundation, while at the downstream end at the foundation will be slightly over fifty feet. Thickness at the crest will be twenty-

five feet and at the base 330 feet. It will contain approximately 625,000 cubic yards of masonry, of which about twenty per cent will be large rock plums imbedded in the concrete mass. There will be a roadway across the top of the dam and drainage and inspection galleries will be placed near the upstream face so as to take care of any slight leakage which may occur during the first few years the reservoir is in use. There will be a very comprehensive gate system for this structure, consisting of a series of large hydraulic and electrically operated gates, four feet to five feet in diameter. Some of the outlets will pass directly through the dam, while others will connect with the diversion tunnel, already mentioned as having been completed.

Mr. Teichman, expert of the United States Reclamation Service, who has had experience with a dozen large dams, has been consulted as expert on the outlet scheme of the design, and in all difficult features of the project specialists will be freely consulted to develop the most desirable treatment.

The dam will impound a reservoir almost eight miles in length, with a storage capacity of 345,000 acre feet or one hundred and twelve billion gallons. Spillways will be provided at each end of the dam, which will be capable of discharging the maximum flood.

The formation of the Hetch Hetchy valley is the result of glacial scour and stream erosion. The valley proper was originally much deeper than at present and was later filled up with sand, gravel and detritus to its present level. The depth of this sand and gravel deposit in the main portion of the valley, perhaps several hundred feet, is not known, nor is it important. At the dam site, diamond drill borings were made, under my direction, to determine the exact depth to bedrock. This depth will average in the stream's bed about seventy-five feet to clean, solid, monolithic granite beneath clean, sharp river gravel and sand which has filled the original channel, over the entire area of the main dam. Where the foundations for a temporary diversion dam, one hundred feet upstream from the upper toe of the dam, have been completed, the depth is much greater, in spots being over one hundred and thirty feet. About fifteen feet of this depth can be reduced by dredging out a bar one-half mile downstream from the dam site, which will reduce the working water heads to sixty feet at the main dam site and make the foundation problem quite simple.

The depth of seventy-five feet from stream bed to bedrock at the main dam site is not excessive for a structure of this character. There are numerous instances where dam foundations have been carried deeper. As a typical example the Kensico dam on the Catskill aqueduct is cited. The Kensico dam has just been completed and forms one of the

main reservoirs in the water supply of Greater New York. For that structure the foundations reached a maximum depth of one hundred and thirty feet below streambed, through defective formations, and a considerable portion of the dam required excavation to depths of from fifty to eighty feet.

The foundation for a dam recently constructed in San Diego went one hundred and fifteen feet below the water surface to a foundation and presented small difficulties in constructing.

The water released from the Hetch Hetchy reservoir will at first stage of construction flow twelve miles down the bed of the Tuolumne river to the point of diversion, which is called the Early intake, elevation 2320 feet. At this point a concrete dam is to be constructed to turn the city's water supply from the river into the aqueduct.

There is already under construction a canal to lead 130,000,000 gallons of water daily from the Cherry river to a 3,000 kilowatt hydro-electric plant, where power will be generated for the construction of the main dam and aqueduct. This canal will safeguard for all time the city's water rights from enterprising poachers who have heretofore successfully exploited us, and will be extended so as to be capable of discharging above the Early intake diversion dam and thereby the waters of Cherry creek and Lake Eleanor will become available for transmission to the city, along with the water from the principal reservoir at Hetch Hetchy.

After the original filings of Mayor Phelan made under Engineer Grunsky's advice in 1901 and 1902, the city's rights were neglected, and as soon as Mayor Phelan went out of office a band of enterprising people filed claims on the water rights of Cherry and Lake Eleanor, and it cost the city \$1,050,000 to subsequently remove those gentlemen. Hereafter, with the city's construction scheme, there will be no opportunity for exploiting the city's holdings by enterprising promoters.

From the diversion dam at Early intake there will be one-half mile of aqueduct built along the side hill and in this section will be installed a venturi water meter and settling chambers for the removal of any sand or silt that may be found in the water during the flood season.

Tunnel Construction

At the end of this half mile we come to the main portal of the first tunnel. The aqueduct from here to the Priest forebay reservoir will be built at once to the full ultimate capacity of four hundred million gallons daily. As the city is compelled under the power requirements of the Hetch Hetchy grant to progressively add to the output, and to prudentially safeguard its future needs, a tunnel in this zone of a

capacity of four hundred million gallons daily, is therefore considered desirable.

This tunnel will have a total length of eighteen and three-tenths miles, terminating at a small reservoir, whose purpose I shall describe later. This long tunnel is the controlling time feature of the entire Hetch Hetchy development, as its completion controls the time that must elapse before the water can be put to use, for there is one section four and one-half miles in length through very hard rock, which must be driven either from the two ends of the section (except a deep shaft is used) and it is estimated that between three and four years will be required to construct this single unit.

The original plans of the Hetch Hetchy development contemplated the use of a canal along the Tuolumne river canyon instead of this tunnel, which I have just mentioned, but by resorting to tunneling we eliminate the possibility of interruption of service due to landslides, snowslides, rolling boulders, or any other external cause, and an additional advantage is that a pressure head will be maintained in the tunnel, so that as the demand for water at the lower end of the tunnel fluctuates, the flow will be regulated automatically and instantaneously. The tunnel is to be lined with concrete with a net diameter of ten feet three inches.

For the entire distance the tunnel will be in rock, which would stand up without support, and a careful study was made to determine whether it would be more economical to build the concrete lined tunnel or to enlarge the cross-section to such an extent that the additional size would compensate for the retardation of flow, due to the rough rock surfaces. It was found, however, after careful investigation, that the unlined aqueduct would require an area twice as large as the net area of the tunnel with concrete lining, and that the latter would be somewhat cheaper as well as being more satisfactory in general. All of the tunnels therefore are planned to be lined with concrete.

Power Plants

At the westerly end of this tunnel will be built the Moccasin creek power plant, the first hydro-electric installation which the city will construct for commercial use. It will be fed with water from the reservoir previously mentioned. The fall is over 1328 feet and the station is planned to generate from the first installation an average of 66,000 horsepower, with a peak load capacity of 100,000 horsepower. This plant will deliver an average load of 43,700 kilowatts in San Francisco with a peak load of 67,200 kilowatts. It will contain ultimately six units of 12,500 kilowatts generators.

The water wheels, owing to the high head, will be of the impulse or Pelton type of wheel. The power generated at this plant will be transmitted approximately one hundred and fifty miles to San Francisco at 110,000 volts. It is not the programme at this time to develop the entire plant capacity at once; probably two of the units will be installed at first, which will have sufficient capacity to take care of the city's railways and lighting, in conjunction with this initial development at Moccasin creek.

By the time the power market has absorbed the full output of this power plant, we will have developed a second plant at the Early intake. For that purpose a twelve-mile tunnel will be constructed from Hetch Hetchy to a point above the Early intake, thereby conserving the head of 1150 feet, which previous to that time will have been wasted on account of the water flowing directly through the river channel. This second plant will have a capacity of about 90,000 horsepower.

The term "Early intake" is used with reference to the first point of diversion in contradistinction to the fact that ultimately the water will enter the aqueduct immediately upon being released from the Hetch Hetchy reservoir.

We return now to the Moccasin creek power plant. After passing through the wheels, the water will continue its course through another section of tunnel seventeen and four-tenths miles in length to the tunnel portal in the easterly foothills of the San Joaquin valley. Here the ground becomes too low for further tunneling so the aqueduct continues westward in the form of steel pipe, forty-five and two-tenths miles in length, crossing the valley and the San Joaquin river a few miles north of Modesto to the west foothills.

The first pipe to be installed will be five feet in diameter and carry sixty million gallons daily, and additional pipes will be added later as may become necessary on account of increased demand.

We now enter tunnel again. This time, however, the tunnel section, instead of being designed at once to carry the full ultimate supply of four hundred million gallons daily, is planned for only one-half of the total.

The slope of the hydraulic gradient here is much lower than in the Sierra Nevada, requiring a much larger tunnel to carry a given quantity of water, and in this case the difference in size between a tunnel to carry four hundred million gallons daily and one for two hundred million gallons daily (thirteen feet and ten feet in diameter, respectively) is so great as to justify the plan outlined of building the smaller tunnel and duplicating it later, thereby saving interest for many years on the excess cost of the larger tunnel.

By tunneling the Coast Range, we avoid the necessity involved in the earlier plans for the Hetch Hetchy project, of pumping the water over the summit of the range, which is about 350 feet higher than the tunnel line will be. Figuring the cost of pumping at three cents per million gallons per foot of lift and allowing for friction in pipes, the pumping charge for four hundred million gallons daily would be in the neighborhood of \$6000 per day, or about \$2,000,000 annually. The earlier plans did not contemplate any such large ultimate development as we now propose, and it will be readily seen from the example, how the expansion of the project has involved radical changes in the general scheme.

The Coast Range tunnel is about thirty-one miles in length and terminates near Irvington. If the communities to the east and south of the bay should eventually decide to join with San Francisco to form a metropolitan water district, Irvington will become a main distribution center, from which an aqueduct will extend west to San Mateo county and San Francisco, another north to supply Oakland and the other east bay cities, and a third south to San José.

Oakland in a rather indefinite way has been figuring on an additional water supply, and a committee over there has held meetings every week or two to discuss various questions of water supply, taking in a scope of country from Mt. Shasta to Merced river. It was my pleasure to appear before them a year ago, and I told them that if they could make up their minds and have a water district and evolve a definite project, we would be happy to co-operate with them to the extent of giving them an abundant supply of soft pure Hetch Hetchy water and an outlet for their pipes from the nearest point on our aqueduct at so much per thousand gallons, but we would want some definite assurance of their sincerity in complying with contract requirements.

Continuing towards San Francisco, the pipe form of aqueduct will be resumed, the pipe being as in the San Joaquin valley five feet in diameter and having a capacity of sixty million gallons daily. This section of pipe will cross the bay at Dumbarton as the Spring Valley pipes do at the present time, and will then proceed to the hills west of Redwood City. Here tunnel construction will again be resorted to and all of the aqueduct from this point northerly to the city will be in tunnel, with the exception of a siphon crossing San Mateo creek and two miles of pipe near Baden. Suitable connections will be provided to make use of Crystal Springs reservoir in connection with the Hetch Hetchy aqueduct, so that in case it should become necessary to shut down the supply from Hetch Hetchy, by the use of water in storage in

Crystal Springs reservoir, no inconvenience will result from the temporary cessation of the Hetch Hetchy supply.

The location and design of the aqueduct were governed by the following general considerations: Safety against interruption of water supply; protection of the water supply against contamination; the use of the water for the generation of electric power; the progressive increase in the quantity of water to be delivered following the growth of population and industrial development in the city and its environs; adaptability for use in connection with the reservoir system of the Spring Valley Water Company, comprising the existing reservoirs in San Mateo county, the Calaveras reservoir under construction in Alameda county, and two proposed future reservoirs—San Antonio and Arroyo Valle in Alameda county, and finally, of course, economy of construction.

In the location of all structures careful consideration has been given to the geology. Preliminary geologic studies were made in connection with preliminary surveys and final and detailed studies have been made to determine the final locations.

For the mountain division of the tunnel aqueduct, that portion from Early intake to Priest hill, the geologic studies were supplemented by diamond drill borings. This was in order to reduce to a certainty the nature and structure of the rock formation to be traversed. This division, as shown by geologic studies and confirmed by test borings, is practically entirely through granite and related rocks and will offer no difficulty to construction. From Priest hill to the Oakdale portal, where the San Joaquin valley division begins, the geological studies of the present location show a region of slate, schist and porphyry, together with a slight amount of serpentine. These are all firm rock formations and present no difficulties in tunneling.

However, as in the case of a mountain division before construction is undertaken, test borings will be made along the route of the aqueduct to disclose the exact nature and hardness of the material to be penetrated. From the Oakdale portal across the San Joaquin valley to the Tesla portal, the geology is of importance principally for estimating the cost of such excavations as are necessary in construction of the steel pipe line. In the lower end of the valley near the San Joaquin river there is a small area of alkali to be traversed by the pipe line, and through this area the pipe will be either protected by a heavy concrete casing, or perhaps by placing the pipe on an embankment sufficiently high to keep it free from the alkaline waters. From information and extensive experience in driving fifty miles of tunnels I am convinced that no serious difficulties will be encountered and not one-

tenth of those found in driving Twin Peaks tunnel, where five hundred feet of quicksand was penetrated.

The Coast Range, as we all know, is of recent geologic origin and is subject to shifting and adjustment of the earth's crust, resulting in earthquakes such as partially destroyed our city in 1906. This shifting and adjustment of pressure has occurred along lines which are more or less well defined and which can generally be located by careful field studies. Naturally where there have been huge cracks in the earth's crust and movement along the same, the rock formation would be very unstable and such regions must be avoided in tunnel construction. These so-called fault lines have been, so far as possible, carefully mapped and aqueduct location has been made to avoid them as much as possible.

The first region of doubt as to final Coast Range tunnel location extends from Tesla portal, about six and one-half miles westerly to what will be known as Carnegie shaft site. This is an area of more or less soft sandstones, shales and slates, together with gravels. Four alternate locations have been surveyed across this region and the surface geology has all been carefully worked out and mapped and the final location here will be determined by test borings. The care being taken in this case is in following out the usual rule of choosing the most economical and at the same time safe location. From the Carnegie shaft site to the Irvington gate house, the tunnel location traverses, except for a small region of gravels, very firm ground. The fault lines, or signs of weakness in rock crust, have all been carefully located for this region and, as before mentioned, the tunnel line has been so located as to avoid these where possible. From the Redwood City gate house to a point about one and one-half miles northwest of the town of Baden, the tunnel aqueduct follows down the backbone of the ridge line between the San Francisco bay, Crystal Springs and San Andreas lakes. Immediately to the west of this ridge we have the great fault line, the movement along which caused the earthquake of 1906. However, our tunnel location is in general from three-quarters to over a mile east from this line of movement and therefore is entirely safe. The underground structure of this region is composed mostly of sandstone, serpentine together with a little shale. The serpentine so far as surface indications disclose, is of the harder and more stable variety and no trouble is anticipated in boring through it. The San Bruno mountain tunnel penetrates stable material, sandstones, shales, slates, chert—materials such as were encountered in the construction of the Stockton and Twin Peaks tunnels. The steel siphons from the Coast Range to San Bruno

mountain will cross an old fault line extending from Lake Merced along the southerly toe of San Bruno mountain to San Francisco bay. However, the siphon will be located on firm ground and the danger from earthquakes will be very small.

The work of acquiring rights of way for the construction of the Hetch Hetchy tunnel aqueduct was commenced in the early part of 1917. All the rights of way have been acquired for the mountain division of the project—that is, from Early intake to Priest regulating reservoir above the Moccasin creek power house. A large portion of the aqueduct route in the mountain division is through Government lands, to traverse which right of way was given the city under the terms of the Hetch Hetchy grant. For the remainder, eleven parcels of land on this division have been secured in fee simple, with a view to using the surface for transmission lines, while the aqueduct tunnel will be constructed beneath. The necessary lands have been acquired for the various shaft sites and drill hole sites, as well as a sufficient drainage area to protect the Priest reservoir from pollution.

Work on the acquisition of the right of way through the valuable lands of the San Joaquin valley will be undertaken in the immediate future.

Already twenty-four contracts for the Hetch Hetchy construction have been entered into by the city. Most of these have involved comparatively small amounts and were for the preliminary pioneering work on the project.

The principal contracts were for transportation, railroad and construction on the Lower Cherry temporary power development canal line.

Preliminary Construction

The site selected for the temporary power plant is on the Tuolumne river at Early intake. Here there is available a head of approximately 325 feet. The water for power purposes is diverted from the Lower Cherry creek and is then led through a conduit three and three-tenths miles long, consisting of one and four-tenths miles of open ditch, one and one-tenth miles of flume and approximately one mile of tunnel.

The forebay at the head of the pipe line consists of an enlarged section of the flume and affords a limited capacity for regulating purposes. From this forebay the water is carried to the power house in a forty-two-inch riveted steel pipe approximately 530 feet in length. The thickness of the pipe ranges from three-sixteenths inch at the top to three-eighths inch at the bottom. Some idea of the character of the country will be gained by realizing that this pipe line drops 325 feet in 530 feet, equivalent to sixty-one per cent grade. The power house

building being intended for temporary purposes only is of wood frame covered with asbestos-protected corrugated iron; foundations, however, are of massive concrete necessary to resist the floods; the machinery and equipment are of the most modern type and design and every precaution has been taken to secure reliability of service in connection with the plant. The power equipment installed in the power house consists of three turbines of the Francis Pelton type, designed to operate at 720 revolutions per minute and to develop 1500 horsepower each. These water wheels are equipped with automatic oil operated governors for speed control and pressure check valves to control and limit the pressure surges in the pipe line, due to the change of velocity of the water in the pipe line when regulated. Each of these water wheels is direct connected to a 2300-volt, three-phase, sixty-cycle generator of 1000 kilowatt capacity, with a direct connected exciter operating at 125 volts. The main step up transformers are located in the power house in a space separated from the machine floor. These transformers will raise the voltage from 2300 to 22,000 volts for transmission to the work. These transformers are four in number, one being a spare. They are of the water cooled outdoor type. The power house is provided with a seven and one-half-ton hand operated crane for changing the machine parts. From the power house power will be transmitted for construction purposes some eleven miles to the Hetch Hetchy dam site and some nineteen miles west along the line of the tunnel at each of the construction adits and, at the dam site, transformer substations will be installed for reducing the voltage from 22,000 to 400 or 220 volts, as may be required for the motors. The construction of this plant is almost complete, the machinery is at present being installed and it is expected that power will be available this fall.

Five of the tunnels on the Cherry power aqueduct were constructed under contract by MacArthur Brothers Company, for the estimated sum of \$53,785. The contract was completed in April, 1917. The one and one-tenth miles of wooden flume is also practically completed and also the one and four-tenths miles of open ditch which is now being lined with concrete.

With available money in the fall of 1914 nine miles of twenty-two-foot roadbed was constructed by the Utah Construction Company for \$180,000 from Hog Ranch to the main Hetch Hetchy dam site.

Another contract which is nearing completion was awarded on December 6, 1915, to F. Rolandi, for constructing the Hetch Hetchy railroad, at the estimated sum of \$1,543,080. Since this road is to be operated chiefly for freight traffic, steep grades were permitted, the

maximum being four per cent, compensated, and the maximum curvature thirty degrees.

From its junction with the Sierra railway at Hetch Hetchy Junction, the road extends eastward, crossing two low ridges, extending up a picturesque canyon, known to the inhabitants of Tuolumne county as Sixbit gulch, but recently more poetically named Rainbow canyon by one of the traffic managers of the Southern Pacific Company, who enthused over the beauty of its coloring.

After crossing the Tuolumne river on a steel railway bridge, the railroad continues along the Tuolumne River canyon, past Jacksonville, thence up Moccasin creek and Grizzly gulch to Priest, thence to Big Oak Flat and Groveland, the headquarters for the city's construction in the Sierras. From Groveland, it continues eastward past Hamilton Station, thence descends to the South and Middle Forks of the Tuolumne river, which are crossed on ballasted deck trestles, and finally ascends to Poopenaut Pass, where an elevation of 5064 feet is attained, thence on a continuous four per cent grade descends to the dam site bench at elevation of 3869 feet.

The entire sixty-eight miles traverses a country which is extremely picturesque and will probably be a strong factor in attracting passenger traffic to the railroad, which will be operated as a common carrier.

Over 230,000 tons of freight will be moved eastward by the city over this railroad, consisting of construction equipment and material for the Hetch Hetchy dam and the mountain division of the tunnel aqueduct. Beside this, it is expected that considerable freight will be hauled westerly and from handling this freight, consisting principally of timber, the city will derive a substantial revenue. It is estimated that 2,000,000,000 board feet of lumber can be marketed from the forests which extend along the city's right of way in the vicinity of Hamilton Station.

Your Chairman alluded to the failure to acquire the Spring Valley for thirty-four and a half million dollars. The City Engineer, Mayor Rolph, and City Attorney Long, did all they could to acquire that system for that amount of money, not because they thought it was absolutely worth it, but they thought it was of value to have the question solved and have one ownership, and remove the contention of the private ownership of water from continuous controversies.

Rights of way had to be acquired for railway use thirty-five miles through private lands, and for that purpose and aqueduct rights we have a right of way department under Mr. Searles, who was trained in Judge Lindley's office, and was formerly an assistant of City Attorney Long; and at my request the Mayor and Supervisors designated

Mr. Searles to attend to the legal end of the Hetch Hetchy project; and Mr. Searles has been very efficient.

The farmers along the route have treated us very decently. We have obtained our rights of way for practically \$30,000, about one hundred feet wide. One farmer and miner tried to hold us up for \$200,000 for about five acres, and we took him into the court in Sonora, Tuolumne county, under Judge Nicholls, and a local jury of farmers and miners—due to the energy of Mr. Searles and Judge Curtin, whom we retained—gave that gentleman \$165, instead of \$200,000. The policy of the city in this project is that we are willing to pay any amount of money fairly, but we will use all possible diligence to resist unjust tribute.

The Southern Pacific came to the help of Los Angeles in its aqueduct construction by spending a million dollars on the transportation system, and I am now in touch with Mr. Sproule of the Southern Pacific to see if I cannot induce him to co-operate with the city of San Francisco in the same broad way they helped Los Angeles, and take charge of the operation of the railroad.

Incidentally, there is about two billion feet of lumber along the line of the road, which is tributary thereto, and which would net us about a dollar a thousand and would refund to us in a fair way the cost of the road.

I do not know whether Mr. Sproule will be able to accommodate us or not, but the City Engineer is so busy with other activities that he would desire assistance in transportation problems.

The road is built from Hetch Hetchy Junction up the Tuolumne river, passing through the creek, along the main ridge, through Groveland, South Fork, above the Early intake, through Hog Ranch, into Hetch Hetchy. It is now finished and the rails are laid, but not yet ballasted. The contractor has had considerable difficulty, since he took the contract in January, 1916. Prices of material and labor and everything in the field have been raised, and we have been very lenient with him in the endeavor to get him to finish his contract, and hope to do so in the next two or three months.

The Chairman has made some remarks about the politics in connection with the project. That is a very popular way to talk about every enterprise of the city, and to say about every city official that he has been a politician. Ordinarily you may expect the animal to have horns, but so far as the Hetch Hetchy project is concerned, since my connection with it, I will say to the credit of Mayor Rolph, it has been entirely removed from politics.

There is not a relative of the City Engineer, a Supervisor, a member of the Board of Works, or any municipal official to my knowledge, employed on the Hetch Hetchy project. Neither is there civil service. The City Attorney so construed the law that the city civil service did not apply to the Hetch Hetchy project. So when an incompetent man has to be discharged, we can discharge him promptly. Under ordinary civil service procedure, it takes about six months to discharge a man. First you have to suspend him. Then he has a trial before the Board of Public Works; then he starts his pull to work; then he has an appeal to the Civil Service Commission; then he has a right to hire a shyster and to intimidate the Civil Service Commission. So it takes about six months to separate him from his job. That has been my experience in my first years of office, and I have been exceedingly glad for my peace of mind that we have no civil service so far in connection with the Hetch Hetchy project; and I hope we shall not.

The element of politics is entirely removed. Everything in connection with our city engineering department, our tunnel, our street railway construction, and all the improvements carried on in this city and outside of this city, are entirely removed from politics. They are clean and decent, as they ought to be in a city like San Francisco; and too often do I hear this expression and the sneer about somebody being a politician.

Now, I have briefly sketched for you the main features of the project, and we will have some slides and screens which will show the exact constructive features as we go along. (Applause.)

TABLE I

**Total Expenditures on San Francisco's Hetch Hetchy Water Supply from
All Sources**

General Fund, 1900 to 1910.....	\$118,219.93	
1909 Water Supply Bond Fund.....	603,215.06	
1910 Water Construction Bond Fund.....	3,675,749.99	
	<hr/>	\$4,397,184.98
Expended for the following purposes:		
1. General and Legal Expenses.....	\$142,677.48	
2. General Engineering	185,464.58	
3. Water Supply Investigations.....	358,452.36	
4. Railroad Surveys and Construction.....	1,411,800.19	
5. Hetch Hetchy Dam and Appurtenances.....	374,608.23	
6. Aqueduct Surveys and Construction.....	150,575.82	
7. Lands, Water Rights and Rights of Way.....	1,404,702.07	
8. Lower Cherry Power Development.....	327,424.17	
9. Miscellaneous Expenditures for Roads, Trails, Wells, Telephone Lines, etc.....	41,480.08	
	<hr/>	\$4,397,184.98

TABLE II

Statement of 1910 Water Construction Bond Fund

September 12, 1917.

Summary

Total bonds sold.....	\$5,825,000.00
Total premiums	1,348.00
Sundry credits from Freeman reports, etc.....	1,952.38
	<hr/>
Total available from proceeds from sale of bonds, etc., Sep- tember 12, 1917.....	5,828,300.38
Total expenditures to September 12, 1917, as per attached statement	3,675,749.99
	<hr/>
Total amount of cash on hand, September 12, 1917.....	2,152,550.39
Liabilities on contracts, etc., outstanding September 12, 1917..	602,285.85
	<hr/>
Net amount available for additional contracts and further ex- penditures by day labor.....	\$1,550,264.54
Summary of actual cash expenditures to date on the Hetch Hetchy water supply from all sources (includes amounts actually paid only—no liabilities):	
General Fund, 1900 to 1910.....	\$118,219.93
1909 Water Supply Bond Fund.....	603,215.06
1910 Water Construction Bond Fund.....	3,675,749.99
	<hr/>
Total expenditures (cash).....	\$4,397,184.98

(Note: From books of Mr. Williams, accountant for Board of Supervisors.)

TABLE III

1910 Water Construction Bonds

Total issue authorized \$45,000,000.00.

To mature at the rate of \$1,000,000.00 annually commencing July 1, 1920.

Date of Maturity	Issued	Unissued
1920.....	\$285,000	\$715,000
1921.....	285,000	715,000
1922.....	285,000	715,000
1923.....	285,000	715,000
1924.....	285,000	715,000
1925.....	285,000	715,000
1926.....	285,000	715,000
1927.....	285,000	715,000
1928.....	285,000	715,000
1929.....	285,000	715,000
1930.....	85,000	915,000
1931.....	85,000	915,000
1932.....	85,000	915,000
1933.....	85,000	915,000
1934.....	85,000	915,000
1935.....	85,000	915,000
1936.....	85,000	915,000
1937.....	85,000	915,000
1938.....	85,000	915,000
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1957.....	85,000	915,000
1958.....	85,000	915,000
1959.....	85,000	915,000
1960.....	85,000	915,000
1961.....	85,000	915,000
1962.....	85,000	915,000
1963.....	85,000	915,000
1964.....	85,000	915,000
Totals.....	\$5,825,000	\$39,175,000

Discussion by the Meeting

Remarks by President Hodghead

THE PRESIDENT: The paper of Mr. O'Shaughnessy, the City Engineer, including the part which he read and the part which you will read and the statistical tables which will be appended, certainly brings this Hetch Hetchy project down to date in a very exhaustive way. The speaker will freely agree with me that there was a period of time when there was a little politics mixed up with the withdrawal of the Hetch Hetchy grant.

In order to enable you to bear these facts in memory a little more easily and more distinctly, Mr. O'Shaughnessy will illustrate the progress of the work there, the physical features of the work, by the lantern slides, and if you are ready we will put those on now, Mr. O'Shaughnessy.

(After a series of slides illustrating the progress of work done the proceedings were continued as follows:)

THE PRESIDENT: It scarcely seems necessary for any one to go to Hetch Hetchy now, after looking at this group of pictures. I am sure we are very much obliged to Mr. O'Shaughnessy for the information and also the entertainment which he has furnished us this evening.

We have considerable time left yet, if any one is not satisfied with this report Mr. O'Shaughnessy has given, or has anything to add to it he will now have the opportunity.

We have a great many of the old champions of Hetch Hetchy here this evening who have been in this contest from beginning. We certainly should hear from some of them, or all of them. Mr. O'Shaughnessy stated he would be very glad to supplement his talk by answers to any questions that any one may ask concerning the progress of this construction work. Has anyone anything to add to the discussion or any question to ask of the speaker? This report carries us back to December of 1906, when we began this discussion of water supply of San Francisco, and, as I said at the opening, we invited Professor Marx of Stanford to read a paper on that subject. I wonder if Professor Marx, who is with us tonight, has changed his opinions expressed at that time upon any of the questions considered? Can you start this discussion, Professor Marx? I am sure we would be very glad to hear from you.

Remarks by Charles D. Marx

MR. MARX: There is very little that I can add to what Mr. O'Shaughnessy has brought before you, but it may perhaps be of interest to you to hear a little something of what took place at the time

the city decided to give up its right to the Hetch Hetchy, i. e., practically to nullify the work which had so ably been done by Mr. Grunsky previous to that time.

Some of you may remember that at that time Colonel McKinstry, of the United States Corps of Engineers, Mr. A. M. Hunt, now member of the Naval Consulting Board, and myself, were appointed by the Schmitz Board as a Board of Consulting Engineers to pass on various plans and to recommend that plan, out of those submitted, which in our opinion was the best.

A number of projects, partly developed, were submitted to us. Only one of those projects had been worked out to some extent and presented engineering data. As soon as we got together we realized that it would be impossible, with the information before us, to arrive at any decision that would justify us in making a recommendation; and we therefore at once appealed to Mayor Schmitz and said, "We will need a long time and considerable money in order to make the necessary investigation and to supplement the engineering data for these other projects that have been submitted." Mayor Schmitz took the stand that in all probability that could be arranged, and we laid our plans accordingly.

But before we went into action I remember going down with Mr. Hunt and Colonel McKinstry and meeting one of the gentlemen who was quite prominent in the then Board of Supervisors—Big Jim Gallagher, I think was his name—and we spoke to him about the work; he said, "I don't see why you need so much time. Why, I would settle that by flipping up a quarter." I think he meant a larger sum, but that was the amount mentioned at the time. However, we did succeed in arranging, at least, for a meeting. I remember it was on a Saturday morning that I received a special delivery letter from Mayor Schmitz asking the members of the consulting board to meet with the special committee of the Board of Supervisors on water supply at his office that morning. The other members of the board, it being Labor Day, had gone out of town, so that the then City Engineer, Mr. Woodward, and myself, were the only ones who appeared at Fillmore street, where the Mayor at that time had his office. The members of the special committee marched in that morning headed by Mr. Abraham Ruef and then began a conversation carried on largely between Mr. Ruef and myself.

I told him that of all projects submitted there was only one, that of the Bay Cities Water Company, that had any adequate data or that would enable us to judge of its value as a probable source of supply. "Well," he said, "couldn't you take that up first and report on that, as

regards its adequacy and the quality of the water?" "Oh," I said, "yes—yes, we can do that." "Well," I said, "however, there is one obstacle, Mr. Ruef, and that is, that the resolution as passed by your Board of Supervisors, asked us to compare the various sources and to make our report on this comparison, and unless these orders are changed, I do not quite see how we are going to do that." "Oh," he said, "that is all right. At the next meeting of the Board we will have that changed, so that you can proceed along those lines." I said, "All right," and we left.

That was Saturday morning. Upon Tuesday morning we met at Colonel McKinstry's office and I reported to my colleagues what had taken place the previous Saturday.

We were not born yesterday or the day before, and so we said, "This thing has come to a show-down and we will at once hand in our resignations." So we made an appointment—we telephoned to Mayor Schmitz' office and asked whether we could see him the next morning, which was Wednesday. He said we could. As it happened, that particular Tuesday evening Mayor Schmitz went down to Santa Cruz to that famous convention which was held on Wednesday, and when we appeared at his office on that Wednesday morning Mayor Schmitz was not there. So we asked for paper and pen and sat down in his office and wrote out our resignations.

We heard nothing from that at all. We had merely stated that in view of the fact that the conditions under which we had been appointed were likely to be materially changed, we hardly felt as if we cared to report on the projects in that way, because we fully realized, for instance, that if we had taken up at that time the project of the Bay Cities Water Company, which was the only project which had been worked out in any considerable engineering detail, and which on the face of it was the only project that had any merit, we would put ourselves in a very delicate and trying position. So, as I said, we handed in our resignations, and heard nothing more for some days.

Then—I think it was the latter part of that week—Mr. Hunt—I think Colonel McKinstry was not here at that time—and I went to Mayor Schmitz' residence. I have forgotten the exact place where he lived at that time. He tried to get us to reconsider our action, but we told him plainly how we felt about the matter and that unless we were put in a position of making what we considered a fair report on the various projects, we declined to have anything to do with the case. He told us then, "I think I can bring that about," but before he succeeded in bringing it about, some of the gentlemen found themselves, if not in jail, almost in jail, and the whole matter was dropped. I only

remember that the matter was later brought up before the Board of Supervisors and I myself was excoriated I think by a Mr. Kelly; he claimed that I proposed to take out of the hands of the Supervisors the power vested in them, and I got a good drubbing. However, the matter ended then and there, and our connection with the project ceased at that time.

It was a little later and at a time before I felt justified in bringing those facts out in public that the Commonwealth Club took up this question of a water supply for the city of San Francisco, and my colleagues and myself were asked to report on the various phases of the project.

THE PRESIDENT: I do not want to interrupt you, but at this point I would like to ask Mr. O'Shaughnessy if the Chairman was correct in his first statement? (Laughter.)

MR. MARX: I am inclined to think, Mr. President, and Mr. O'Shaughnessy, that there were some politics in the administration of the city of San Francisco even in the conducting of civil engineering work at that time, and it was for the purpose of advising the city in the matter of taking up the project and carrying it through in a way in which a project of that kind should be carried through—and I am glad to know that it is now being carried through—that we appeared before your Club at that time.

I think it was suggested by the Commonwealth Club that we should make a recommendation, which we hardly felt qualified to do, for I stated at the time that you could hardly expect three men to suggest the best probable source of water supply in an evening when only a week before we had refused to make a report on anything of the kind in less than a year. (Laughter.) It has taken somewhat more than a year to arrive at what seems to be a very satisfactory and intelligent solution. (Applause.)

Questions and Answers

MR. HENRY E. MONROE: I would like to ask Mr. O'Shaughnessy a question: Was it known at the time that the estimate was made as to the cost of the dam, what depth you would have to go to your foundation?

MR. O'SHAUGHNESSY: Yes, the estimate was made for the original project of \$45,000,000, upon which the bonds were voted in 1910, and since then the project has been entirely recast.

MR. MONROE: Then, as I understand you, the plans would probably have to be entirely revised, when the plans are finally determined on?

MR. O'SHAUGHNESSY: The estimates now made cover substantially the construction of the project from Hetch Hetchy to San Francisco, except the power features. The power features will have to be subject to a vote of the people.

MR. MONROE: The estimate was made for bringing the water simply to the elevation of University Mound. Will those figures have to be revised?

MR. O'SHAUGHNESSY: A part of them.

MR. MONROE: The estimate of the present cost has not been worked out, has it?

MR. O'SHAUGHNESSY: Yes, it has been worked out.

MR. MONROE: Do those figures stand?

MR. O'SHAUGHNESSY: Those figures stand, to bring the water within the city limits.

MR. MONROE: And that includes the estimate of interest on deferred payments?

MR. O'SHAUGHNESSY: Interest on deferred payments is not included in the estimate.

MR. MONROE: Some of the bids that were obtained on the tunnels were very much higher than the estimates, were they not?

MR. O'SHAUGHNESSY: Yes. The bids were forty-six per cent above our estimates. We estimated \$60 a foot for the tunnels and actual bids were about \$93 a foot, for a ten-foot tunnel; and even at the time I believed those figures were excessive, because a tunnel eight feet in diameter 8700 feet long is now being built in Marin county for \$29.70 a foot and a tunnel in Chicago, five miles under Lake Michigan, twelve feet in diameter, is being built for \$67.50. So we are satisfied with our estimates.

MR. MONROE: If it is necessary to pay those prices, how much would that add to the cost?

MR. O'SHAUGHNESSY: It would add possibly five per cent.

MR. MONROE: To the total cost?

MR. O'SHAUGHNESSY: To the total cost.

MR. MONROE: And you think that you can have the work done at those figures?

MR. O'SHAUGHNESSY: I feel satisfied, because when our railway was built in 1914 we bought copper for 15 cents a pound, and copper is now about 40 cents. Steel rails are up about sixty per cent. So that the construction at that time was normal, and our position is to sit down and go slow until conditions adjust themselves.

MR. MONROE: In other words, the estimates were based on conditions that existed prior to war?

MR. O'SHAUGHNESSY: Yes.

MR. MONROE: And if the prices remain high—

MR. O'SHAUGHNESSY: We will have to get more money.

THE PRESIDENT: Any other questions?

MR. PEIRCE: What proportion of that estimate of \$45,000,000 do you figure as labor?

MR. O'SHAUGHNESSY: About fifty per cent.

MR. PEIRCE: That is twenty-two and a half million, and that is based on wages of how much?

MR. O'SHAUGHNESSY: Wages of \$3 a day on labor.

MR. PEIRCE: Now, it is a fact that we all admit that there is a tremendous shortage of labor today all over the country. Under war conditions and conditions that will exist probably in this country after the war, is it not likely that you will not only have a great scarcity of labor to continue the work, but it will be much higher?

MR. O'SHAUGHNESSY: I do not contemplate that it will be scarce, for the reason that with the power we are going to use we are going to minimize the number of laborers as much as possible, and in the mountain regions where we are working, we have practically no labor difficulties. The men have been well treated; they have had good meals, and they are very happy working on the city work. So I do not anticipate labor troubles.

MR. PEIRCE: It is the question of competition for labor; that is what I mean.

MR. O'SHAUGHNESSY: Of course, the general condition in the whole country is very serious. We used to have a million immigrants coming in annually, mostly laborers, and that supply is all cut off, and that means, with the million men in military and naval service, a shortage of four million, and a great many projects will be crippled for want of labor.

MR. PEIRCE: It is not a question of principle at all, for the reason that it is something that nobody has any control over. Is it a fair assumption that the Hetch Hetchy project will cost at least fifty per cent more than otherwise because of scarcity of labor and materials?

MR. O'SHAUGHNESSY: That depends. I would not be inclined to pay the exorbitant price of fifty per cent additional for the material or an exorbitant price for labor, but during the period of that kind, we will go slow.

MR. PEIRCE: Of course, the condition may last a long time.

MR. O'SHAUGHNESSY: It may last two years.

MR. MONROE: In the estimates which were made of the cost to San Francisco was the project credited with the probable returns from power?

MR. O'SHAUGHNESSY: No.

MR. MONROE: What do you estimate they might be?

MR. O'SHAUGHNESSY: I believe our power a valuable asset—the army board estimated 115,000 horsepower as being worth \$45,000,000. I think their estimate is a little bit excessive, but as a matter of fact there are over 200,000 horsepower ultimately in this project, when we use the water on the higher levels. We get 150,000 horsepower on the line of the aqueduct between Hetch Hetchy and Moccasin creek, but there are other drops higher up in our 420,000 acre watershed, from which, in the future, we can get more water and more power, and it is a very great asset.

MR. MONROE: Was there a stipulation that it can be sold?

MR. O'SHAUGHNESSY: The only stipulation is that under the terms of the grant we cannot sit idly by and sleep on the power development; we must proceed to develop it at least on the installment plan. We have to use it and create a certain amount of power in a certain time, and a certain amount later on. Our bill for Municipal railway power in the city is \$27,000 a month at the present time, and our carlines are going to increase; the general activities and future needs of the city are going to increase, and there will be a good deal of use for power.

Remarks by President Hodghead

THE PRESIDENT: While we are hearing from the administration, I know we would be very interested in hearing from Mayor Rolph, who came in and slipped into a very modest position a few minutes ago. We are talking about Hetch Hetchy. We would be very glad to hear from you. (Applause.)

Remarks by Hon. James Rolph, Jr.

MAYOR ROLPH: I thank you, Mr. President, for inviting me to say a few words, but I came here this evening for two purposes: First, to be enlightened and assisted in the responsibilities which I have as head of the city administration over this Hetch Hetchy work; and, secondly, to lend by my presence encouragement to a splendid public official, City Engineer O'Shaughnessy. (Applause.) He occupies the position of city engineer because I prevailed upon him to give up private practice and take up public work and to give of his talents and of his energies

and of his splendid well-known ability, to the service of this city. He has been occupying this position now for a number of years, and the city has entrusted him with many large and important problems. I do not come here tonight to extoll him or to flatter him or to say kind words about him, because I think you all appreciate his work. The evidences of it are to be seen on every hand. The building of the tunnel, the building of the municipal railway lines, the building of the roads around this city, the improvement of the streets, the completion of the high pressure system, the building of the esplanade, the building of the road around Twin Peaks, and all the great public improvements that have been entrusted to him, speak more eloquently than any words that I can utter tonight in his behalf. (Applause.)

The people of San Francisco have entrusted him with the expenditure of \$45,000,000 in the building of this great water supply for San Francisco. We all know the fight we have been through in securing the Hetch Hetchy grant. We know the great tribute that Secretary Fisher paid him in Washington; you know the tribute that Secretary Lane paid him; you know the conferences that he has been called to attend in Washington, because Secretary Lane and other statesmen of the United States have believed in his ability. And tonight you see there, by the views that he has given us on the screen, and by the splendid paper he has read, that he knows what he is doing in the building of the Hetch Hetchy in the high Sierras. You see the work going on; you see the railroad being built; you see the dam under construction; you see the Hetch Hetchy site cleared of the trees that once occupied the floor of that valley; and you have not heard a breath of scandal, and you have not heard a breath about expenditure of public funds wastefully; and you have found out your city engineer is spending money economically, doing it fearlessly and not playing politics. (Applause.)

He made one statement tonight in which I did not quite agree with him, and that was that in the purchase of Spring Valley, he said that we were willing to pay thirty-four and a half million dollars for the property, not that we considered it worth that amount, but that he considered that the city should acquire it.

I favored the purchase of Spring Valley because I believed it worth the money; I favored the purchase of Spring Valley then and always favored the purchase of Spring Valley, and favor the purchase of Spring Valley now at the best offer we can get it at from the owners, and I think the city should acquire it at the earliest possible date.

I believe that the defeat of the Spring Valley purchase was a great loss to this city. We not only lost one and a quarter millions of impounded money which was to come back to us in the thirty-four and a

half million dollars purchase price, but we have lost the accrued profit that has come to the company since we turned down the purchase. That institution is growing just like San Francisco is growing, and we need at the earliest possible date the properties of the Spring Valley Water Company to complete our water supply for San Francisco.

Hetch Hetchy is going on. It is true that the option on the eleven million dollars worth of bonds was not taken up by the bank that had it; \$1,100,000 worth of those bonds were taken and the option on the balance of the eleven million was declined. But that work of Hetch Hetchy, Mr. President and fellow members of the Commonwealth Club, must go on. We must find the money to complete that project. We must finish that power plant to get a revenue that will come from it; and we must assist the City Engineer in disposing of the bonds in the economical manner which he has outlined for the prosecution of that work. Members of the Club should assist him; the Commonwealth Club should get back of him. If we do not need to sell all the eleven million dollars worth of bonds at the present time, you should assist the City Engineer in disposing of such amount of bonds as is necessary, so that that work will not be stopped.

This city must go ahead. It has now five hundred and fifty to five hundred and seventy-five thousand population. This water supply that we have is not alone for San Francisco. This water supply is a metropolitan water supply in which Oakland, Alameda, Berkeley and all the cities around the bay have an opportunity of joining us.

I wish in closing to say that I hope the time is not far distant when we will own the properties of the Spring Valley Water Company. I am sorry that the City Engineer tonight has not here views of the work being prosecuted over at Calaveras dam; I am sorry that he has not shown the work that is going on since we turned down that project; and I am sorry that he has not views to show you here tonight the absolute need of placing water in districts of this city that are without water. There is hardly a day that my office does not receive communications urging us to supply water in populous districts; and we will never be able to solve the problem until we own the properties of the Spring Valley and complete the work on Hetch Hetchy. I hope the Club will get back of the City Engineer and assist him financially, morally and in every respect to carry on to a successful completion the work that he has so nobly and ably begun. (Applause.)

THE PRESIDENT: Come and see us again, Mayor.

I think we should go back a little further into the history of the Hetch Hetchy project and begin with Mr. Grunsky, who recommended

this source of supply in the first place about 1901. Mr. Grunsky, may we have a word from you?

Remarks by C. E. Grunsky

MR. GRUNSKY: I did not come here this evening with the intention of saying anything with reference to the water supply. On this subject I have written and I have talked at various times until I believe the members of the Commonwealth Club and the people of San Francisco know my views.

I have from the beginning, from the time that I first investigated the water situation of San Francisco, been convinced that the water supply system should be municipally owned; and that a beginning should be made with the acquisition of the properties of the established water company.

I held that view at the time that I was City Engineer, when I made my first progress report on the water situation, and I incorporated that in a mild way in the report which I made on the Hetch Hetchy system. When I recommended the Hetch Hetchy as a source of water to the city, as the best source that could be obtained, as an auxiliary or as an addition to the waters that could be developed near to San Francisco and were already to a large extent in use, I stated that the proper course would be to acquire the properties already in use and add thereto the most available water from the high Sierras, which my investigations convinced me is water from the Tuolumne river. The project as it was outlined by myself and then adopted by my successor, Mr. Manson, as Mr. O'Shaughnessy has pointed out, differed in some respects from the project which is now under construction. On that subject I do not desire to say anything further than has already been incorporated in the Club's printed reports of the past.

I believe that the water situation, the whole water question, should have been handled from the beginning by a water board. This statement I have made repeatedly, and I simply wish to call to your attention the fact that the water board method of control would have been of large advantage to the city, particularly if the water board had been established early in the history of these water supply investigations. I refer to the time when I was still the City Engineer.

I again call attention to the fact that the entire bay region is developing very fast, and the need for additional water, for water from remote sources, is quite as pressing on the east side of the bay as it is in San Francisco. There should be—as has been pointed out in this Club, which has gone so far in this matter as to prepare a bill which, if enacted into law, would make it a reality—there should be a bay water

district. Water should be brought into this region by a combination of the cities around the bay of San Francisco and wholesaled to the individual communities.

These matters have been brought to the notice of this Club at various times, and have been quite fully discussed. There is no occasion, either, for comment by me at this time on what we have learned tonight about the progress that has been made in bringing the mountain water to San Francisco. (Applause.)

Remarks by President Hodghead

THE PRESIDENT: Mr. Grunsky referred to his successor, Mr. Manson, who is present this evening, and who took this matter out of politics after the incident which Professor Marx, without any prearrangement with the Chair, has detailed at some length. Mr. Manson, it would be interesting if you would contribute to this discussion.

Remarks by Marsden Manson

MR. MANSON: There can be little added to what has been said tonight and what is already in your printed records and available public records. There are two instances, however, in looking into the history of the water supply from Tuolumne river, it may be well not to lose sight of.

In the latter part of the last century, I find in looking over the records, the Geological Survey, prior to the adoption of our new charter in 1900, selected Hetch Hetchy and designed a dam for that site, and called attention to the fact that that valley was one of the best reservoirs for supply to San Francisco and the bay cities. Going back still further into history, I find that when the state employed one of the most distinguished economic geologists in the country at that time, Professor Whitney, as State Geologist, he went through the various portions of the Sierra, looking at its mining and general economic possibilities, and I think in the latter '60s called attention to the fact that Lake Eleanor was one of the best sources for the water supply of San Francisco. He made that statement in public in a lecture which he was requested to deliver to the Legislature of the state, then in session.

To show you how intimately politics at that time entered into the affairs of the water supply of this city, despite the wonderful wealth that Professor Whitney's abilities could point out for utilization, after he recommended a Sierra source as a desirable one to acquire water for this city, the appropriation snapped short off, and never one dollar was appropriated by the Legislature of this state for the development of its economic geological resources. I believe, in looking into that history,

that the then water company and the interests it represented, was sufficiently powerful in the Legislature to shut off any further assistance in the matter of studying our natural resources under the auspices of even such a man as Professor Whitney.

Immediately the cue was taken, and a group of citizens filed on Lake Eleanor. I have seen the foundation of the dam which they put in. It, however, passed into disuse; their rights lapsed, and a long interval of time between the '60s and early '70s, and no movement being made by San Francisco, that right was lost.

Those two little incidents with regard to the history of our water supply and our struggle to develop it, are well not to forget. There is nothing that I could add to the discussion, Mr. President. The work is progressing and in time I suppose we will have the power and later the water from that source. I thank you for your attention. (Applause.)

THE PRESIDENT: Among the engineers here tonight is one who has always been a champion of the Hetch Hetchy from the beginning, both here and before the various committees of Congress and Department of the Interior at Washington. I would like to hear from Mr. Galloway. (Applause.)

Remarks by John D. Galloway

MR. GALLOWAY: I am afraid this discussion lacks vigor as compared to former meetings at which this water supply subject was discussed. Before this it has been a controversy. At the present time it is an accomplished fact and the work is proceeding. Formerly we had a fight on our hands, and that always lends interest; at least it added zest to the discussions, if nothing else.

One or two points have been referred to here tonight, mentioned by the City Engineer and others, to which I might add a little information. Mr. O'Shaughnessy stated that already four million dollars had been expended in the work, of which over one million dollars was for the purchase of water rights which were secured by private parties during the Schmitz-Ruef administration. It represents about one-quarter of the total expense so far. Those who helped to elect Mr. Schmitz can consider this expense as one of the payments that we made for the pleasure of having that gentleman as Mayor, along with his Board of Supervisors.

The subject of power has been mentioned here tonight; the available power from Hetch Hetchy. That is a subject that I am somewhat familiar with, having been one of three engineers who assisted Mr. O'Shaughnessy in the consideration of the subject. There can be developed at Hetch Hetchy from the water which will be available when the plan is completed—not necessarily when it is used, but when it is

completed—from the total flow of four hundred million gallons a day, which is somewhat over six hundred second feet of water—a certain amount of power, or rather energy, which to most men means nothing when expressed in the usual terms of kilowatt hours of electric energy. It can, however, be stated in this way: that the two major power developments at Hetch Hetchy will generate about as much power as is now installed in the mountains by the three large power companies that supply San Francisco, the Pacific Gas & Electric corporation, the Great Western Power company, and the Sierra and San Francisco Power company. You can thus get an idea of how much power will be developed along that aqueduct. If that power is sold at the common wholesale rates of power at the present time, say three-quarter cent per kilowatt hour, either by the city to itself or to power companies, the power that is developed along the aqueduct will bring in a revenue sufficient to pay the interest on practically all of the bonds necessary to build the aqueduct and the power plants; that is, if properly managed the power end of the project will pay for the whole thing.

That assertion has been challenged; it was challenged in the water rate hearing before the Railroad Commission a short time ago in connection with a hearing upon water rates on the other side of the bay, and an engineer who appeared for the East Bay Water company made the ridiculous assertion that to the power development on the aqueduct there should be charged the cost of all the dams and all the aqueducts, including eighteen miles of tunnel—everything above the power plant should be charged to the power plant. Now, gentlemen, I mention that merely for this reason. You will find all sorts and conditions of statements made to belittle every part of the water supply of the city from the mountains, and this particular one was used to throw doubt upon that particular feature of it. You might just as well try to say what is the value of a man's heart and segregate it away from the rest of his body. You cannot do it. The water comes from a certain height in the mountains; it must fall to the lower level; in doing so, power can be generated. You can sell the power and bring in a profit. The power is a part and parcel of the entire scheme, and it must be developed in accordance with the grant from the Government. You cannot separate the power from the balance of the project. To get a clear idea of the situation one must consider that the amount of power that can be developed is, practically equal to the entire existing hydro-electric development of the three largest power companies supplying Central California with power. If wisely managed and sold for ordinary prices, that power will practically pay the entire cost of the installation. That is all I have to say. (Applause.)

Remarks by President Hodghead

THE PRESIDENT: I think we have about reached the peak load of engineers here now, but yet there is quite a supply on hand. I do not know whether they can be induced to speak or not. I do not want to presume to direct this discussion entirely; I would prefer it to be volunteer. Has anybody else anything to add? If the engineers are exhausted, I think we had better draw on the legal profession. Mr. Haven, can you add something to this discussion? You have been long a student of the water question in San Francisco.

Remarks by Thomas E. Haven

MR. HAVEN: Mr. President, I do not think I can add anything from a legal to the engineering standpoint of the project.

One question has been asked me tonight, and I have been thinking of asking Mr. O'Shaughnessy for an answer to it, and that is, why is it necessary to have as much tunnel work in this project as is contemplated in the present plan? As I remember it, the original plans had much less of tunnel work and the cost was much less. The only answer I can get is, we are looking to the future and making a better system of it. I would like to have Mr. O'Shaughnessy speak to that question.

THE PRESIDENT: Will you speak to that?

Remarks by M. M. O'Shaughnessy

MR. O'SHAUGHNESSY: I would say that the march of hydraulic development has made considerable advancement in the sixteen years since the original plans were recorded. Instead of making ditches on the surface of the country—pioneer practice at that time—liable to damage by storms, falling trees, drowning animals and other accidents, it is much more desirable to carry water in tunnels, especially water for domestic use; and not only is that true for domestic supplies for the city of San Francisco, but it is true of the Hawaiian Islands, where possibly twenty separate irrigation works have been constructed in the past fourteen years. They have abandoned building flumes or channels on the surface, and are now tunneling through the mountains, where structures cannot be damaged by storms and accidents. Use of tunnels on the Hetch Hetchy project will probably shorten the distance twenty-five miles, and is therefore good engineering practice. I think that is an answer to Mr. Haven's inquiry.

THE PRESIDENT: Is that answer as good as yours?

MR. HAVEN: I think it is a good deal better. That is an engineer's answer.

THE PRESIDENT: Cannot Mr. Healy, the contractor, add a further explanation.

Remarks by William H. Healy

MR. HEALY: I spent ten days in going over this project from the contractor's standpoint. I was one of the bidders that recently bid on this tunnel. While I agree with the City Engineer in many of his statements, I disagree with him in the matter of the estimates of the cost of the work as compared with bids submitted.

We fear the labor conditions in our line of business. It will be almost impossible to get the men we require. We went into the proposition very thoroughly, and if we were bidding on this project twelve months ago, our bid would have been materially reduced, and at that time we would have made more money than we figure at this time. Mr. O'Shaughnessy deserves a great deal of credit for the work as it has proceeded up to the present time. It was a short time ago when they had nothing but trails there at these mines; it was impossible to reach any of those points; that is, the Early intake—without going down a mule trail. We had no difficulty in going all through there examining every part of the work that was under contemplation. The work at the intake, as Mr. O'Shaughnessy has stated to you, has been done by other contractors. As you noticed, when he remarked about the contractors, they all lost money. Now, as one of the contractors, I do not propose to go down and lose money with the rest of them. (Laughter.) And while I have been on the work, as I said, I would bid with less profit now than I would if I had been called upon last year.

Seeing the work that Mr. O'Shaughnessy has done there, especially on the tunnels, he has one of the greatest picked forces of men I have ever seen. They love him so much that they tell you every minute about how much they love him, and about his ability. They number about 300 men. They are principally Swedes—not an Irishman. Now, those men have been working very faithfully down there. I have met a number of them. They want to work for Mr. O'Shaughnessy, and they want to work for the city. They like the men in charge of the work. They are working for Mr. O'Shaughnessy at \$3 a day. I venture to say that if a contractor took that work tomorrow, their scale of wages might jump as high as five or six dollars. I have in mind the way men in similar work are leaving jobs daily. We have a quarry where we paid from \$2.25 to \$2.75, and men have

been with us for ten years. It is only recently that those men have left us to go out to the mines for \$5 to \$5.50 a day.

The reason our bids are apparently so high is on account of the uncertainty of labor. We do not know when we will be called upon to pay men of every class as high as five or six dollars. There is not a union in town where we are not forced to pay them all sorts of salaries. Some of our five-dollar-a-day men, in structural iron works, have left us to go to Wyoming, where they are putting in snow sheds, burned down there, and those men are averaging seven dollars and seven dollars and a half a day.

Remarks by President Hodghead

THE PRESIDENT: Can any one else be induced to differ with Mr. O'Shaughnessy on any point? We have had the engineers and lawyers and the mayor and contractors. I understand some of the bond buyers are here, and representatives of the Spring Valley. We ought to get up quite a discussion. We would like to hear from any of them.

Remarks by B. Grant Taylor

MR. TAYLOR: I arise to give voice to a thought which occurred to me when Mr. O'Shaughnessy was speaking of the embarrassment caused by giving up the option on the bonds. I presume the thought occurred to quite a good many other gentlemen in this room, and I doubt if in expressing it I will be considered as unpatriotic. Before long we shall probably be called upon in San Francisco to absorb another quota of a Liberty Bond issue. Would it be improper for the same organization which will go out to place those bonds to be called upon by the city to place a sufficient amount of city bonds to carry forward this work? It seems to me it would not, and I do not see why it could not be done. There is one question which I think ought to get into the record at this time—for the benefit of Mr. Hoover—and that is, Mr. O'Shaughnessy, what are you going to do with those potatoes? (Applause.)

Remarks by President Hodghead

THE PRESIDENT: I think we should have had a lantern slide of those potatoes, Mr. O'Shaughnessy. At the next exposition we shall inspect that. I think we might vary the discussion for just a moment, because I want to call on one of our number, who has been a member a long time and an occasional attendant upon the Commonwealth Club, from Los Angeles. He can tell us about the climate there, if

not the water—that is, Judge Lewis R. Works of the Superior Bench of Los Angeles. Judge Works, I wish you would add a word to this discussion.

Remarks by Hon. Lewis R. Works

MR. WORKS: In opposition to the usual custom, I shall not on this occasion say anything about the climate of Los Angeles. The President of the Club presumed upon a long acquaintanceship in calling upon an outsider to speak upon such a question as the one before the Club tonight.

The solution of the Hetch Hetchy problem is, of course, of great interest to the entire State of California, but it is at the same time so peculiarly local to San Francisco that it could hardly be expected that one residing so far from San Francisco as Los Angeles could be in such intimate touch with it as to add very much to the illuminating discussion that has taken place here tonight, from the men who have been long associated with the question from the earliest times up to the present moment. Besides the generous rivalry which has existed between Los Angeles and San Francisco for so many years, which rivalry I may say at times has become almost ungenerous at both ends of the line, sometimes Los Angeles being at fault and sometimes San Francisco, there is still another reason why I should not be called upon, and this is that probably many may feel that nothing helpful to the Hetch Hetchy plan could come from one by the name of Works. (Laughter.)

The President called upon me, I think, because, while I sat beside him during the dinner, I said something to him about the amount of my water bill in Los Angeles. That is a question of great interest to all of you because it is in that question, when the Hetch Hetchy plan has reached its consummation, that the feasibility and the propriety of the plan will have been demonstrated to the water users of San Francisco. I live in Los Angeles upon a lot 50 x 140, with a nine-room house upon it, and all of the water is used for such an establishment. I have a lawn in the front of the place about 30 or 40 x 20 feet in extent; I have a lawn at the back of the house which is about 40 feet square in extent, and quite a number of flower beds and plants needing irrigation. My water bill throughout the year runs from 95 cents a month to \$1.30 or \$1.40 (Laughter)—If I remember correctly.

THE PRESIDENT: Do you have a meter, Judge Works?

JUDGE WORKS: I have a meter, and it is frequently tested. If I remember correctly, I rarely have paid more than \$1.30 a month dur-

ing the four or five years since I built that house. Maybe at times it has run over that. I think the bill that I paid just before going north was \$1.40, this being the dry time of the year.

You will understand, from the situation and climate of Los Angeles, that we are forced to use a great deal more water there than you do use here. We confess that in comparison with San Francisco the city of Los Angeles is in an arid region, and therefore you will understand that I am getting for the amount of money I mention much more water than would be used by one in San Francisco for the care of a similar place.

The question is at once presented as to whether or not such a water rate will pay the interest on the bonds that have been voted by the people of Los Angeles for the installation of the Owens River system, to say nothing of providing a sinking fund to meet the bonds as they fall due. That water rate will probably not make that return.

That is aside from the question of development of power. But aside from that question of the development of power, a small charge for the water rate may be justified in this way: The water user, the one who has improved his property, gets the benefit of the low water rate, whereas the interest on bonds, to some considerable extent at least, is borne in excess proportion by the vacant land in the city limits, and the imposition of a tax upon the land of the city generally for the purpose of paying the principal and interest on the bonds, in effect operates as a taxation upon the unearned increment in the vacant land in the city. That adds a stimulant to the improvement of lands in the city and it gives a benefit to the actual resident of the city as against the non-resident land owners.

But aside from that question, the small charge for water in Los Angeles will be justified when the power gets into use. The charging of a small water rate to the consumer, together with the revenue which may be derived from the use of the power, will pay the interest on the bonds and provide for the sinking fund for the payment of the principal when the time comes for their payment.

What Mr. Galloway has said with reference to this question of the development of power and the immense amount of revenue that can be derived from it, is, of course, true. In Los Angeles we have steadily referred to this power as a by-product of water development, because it is nothing else but a by-product, aside from the question of the cost of the installation of the power system itself. Deducting that cost, everything else that comes from the sale and use of that water is a by-product; because, if not used in that way, the running

of the water down the mountain side would be an absolute loss, and the use of that by-product and the revenue from it will entitle the city to charge a very small water rate and at the same time make the payment of the interest on the bonds and of the principal when the bonds have to be paid. (Applause.)

MR. KEPNER: I would like to ask, if it is in order, what your tax rate in Los Angeles city and county is today? The reason I ask that question is, that I have been informed that the difference between the Spring Valley rates and the water bills of Los Angeles is accounted for by reason of more than half the upkeep or cost of this water being paid in general taxation.

JUDGE WORKS: I do not think that is true; of course, there is an excess of taxes on account of lower water rates.

THE PRESIDENT: If there is nothing else to submit, I will take this opportunity of thanking Mr. O'Shaughnessy for his instructive paper, and we will stand adjourned.

TRANSACTIONS OF THE COMMONWEALTH CLUB OF CALIFORNIA

A full list of the published Transactions of the Commonwealth Club of California will be found in the Progress Report for 1915, pages 603-605. A few numbers of Vols. II, III, IV, V, VI, VII, VIII and IX are still available. Also the following, which may be had by members and libraries at cost:

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